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PCT
INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

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Applicant's or agent's file reference 109248:JHK:SMV:ad	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International Application No. PCT/AU2003/000953	International Filing Date (day/month/year) 29 July 2003	Priority Date (day/month/year) 29 July 2002
International Patent Classification (IPC) or national classification and IPC Int. Cl. ⁷ F04B 43/10, 43/113		
Applicant COMBINED RESOURCE ENGINEERING PTY LTD et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 3 sheets, including this cover sheet.
- ☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 10 sheet(s).

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 23 February 2004	Date of completion of the report 17 November 2004
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer R. SUBBARAYAN Telephone No. (02) 6283 2377

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/AU2003/000953

Basis of the report

1. With regard to the elements of the international application:*

- ☐ the international application as originally filed.
- ☒ the description, pages 1,4-6,8-18, as originally filed,
pages , filed with the demand,
pages 2,3,7, received on 22 July 2004 with the letter of 22 July 2004
- ☒ the claims, pages , as originally filed,
pages , as amended (together with any statement) under Article 19,
pages , filed with the demand,
pages 19-25, received on 22 July 2004 with the letter of 22 July 2004
- ☒ the drawings, pages 1/15-15/15, as originally filed,
pages , filed with the demand,
pages , received on with the letter of
- ☐ the sequence listing part of the description:
pages , as originally filed
pages , filed with the demand
pages , received on with the letter of

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/fig.

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/AU2003/000953

✓ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims 1-46	YES
	Claims	NO
Inventive step (IS)	Claims 1-32,34,35,37,42-44	YES
	Claims 33,36,38-41,45,46	NO
Industrial applicability (IA)	Claims 1-46	YES
	Claims	NO

2. Citations and explanations (Rule 70.7)

D1) GB 2195149

D2) WO 1982/001738

D3) US 4543044

D4) US 5114319

D5) US 6345962

INVENTIVE STEP

Claim 33: Citations D1 & D2 disclose all of the features of this claim except that of the one end of the tube structure being closed. However this feature is disclosed by citation D5 and it would be obvious to a skilled addressee to combine this document with either one of D1 or D2 and thereby arrive at the invention of claim 33. This claim therefore lacks an inventive step.

Claims 36,38-40,45,46: Citations D3 & D4 disclose a pumping system having at least two pumps, delivery means for delivering pumped fluid to each pumping chamber in timed sequence and mean for supplying actuating fluid to each actuating region in timed sequence to cause the pumping chamber to undergo a discharge stroke. Although these documents do not disclose the pumping chambers as including a tube structure, such pumping structures are common general knowledge in the art (as evidenced by citations D1, D2, D5). It would be obvious to a skilled addressee to combine this common general knowledge with the teachings of D3 or D4 and thereby arrive at the claimed invention.

Claim 41: Citation D5 teaches a fluid operated pump in which the tube structure is closed at one end and the other end communicates with a port through which pumped fluid can enter into and discharge from the pumping chamber. However it does not explicitly disclose that the closed end is in an elevated position in relation to the other end. However it is considered that it would be obvious to a skilled addressee that this configuration can be used with the teachings of D6 and would thereby arrive at the claimed invention in a non-inventive manner. This claim therefore lack an inventive step.

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end, with a pumping chamber defined within the tube between the supply and discharge ends. Fluid pressure is employed to compress the tube, thereby urging a charge of the fluid within the pumping chamber towards the discharge end. Various proposals for such pumps are disclosed in US 3,406,633 (Schomburg),
5 US 4,515,536 (van Os), US 6,345,962 (Sutter), GB 2195149 (SB Services (Pneumatics) Ltd), WO 82/01738 (RIHA), US 4,257,751 (Kofahl) and US 4,886,432 (Kimberlin).

Each of these proposals utilise a flexible tube which is elastic so that it is compressible to expel the charge of fluid therein and expandable to receive a
10 further charge of pumped fluid into the flexible tube. Each of these proposals has limitations on the maximum pressure to which the device can operate. The limitation is a result of the maximum pressure differential the flexible tube can withstand if the tube is over-compressed by the pumping fluid. If over-compressed the tube will fail by rupturing at the outlet port.

15 It is against this background, and the deficiencies and problems associated therewith that the present invention has developed.

The reference to the abovementioned prior art is for the purposes of background only and is not, and should not be taken as, an acknowledgement or any form of suggestion that the prior art forms part of the general knowledge in Australia.

20 **Disclosure of the Invention**

According to a first aspect of the invention there is provided a pump for conveying a pumped fluid using a actuating fluid, the pump comprising a rigid outer casing defining an interior space, a tube structure accommodated in the interior space, the tube structure being flexible and substantially inelastic, the interior of the tube
25 structure defining a pumping chamber for receiving pumped fluid, the tube structure being movable between laterally expanded and collapsed conditions for varying the volume of the pumping chamber thereby to provide discharge and intake strokes the tube structure being maintained in a taut condition between the ends thereof, the region of the interior space surrounding the tube structure

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defining an actuating region for receiving and accommodating actuating fluid, the pumping chamber being adapted to receive pumped fluid to cause the tube structure to move towards the expanded condition and the pumping chamber thereby undergoing an intake stroke, the pumping chamber undergoing a
5 discharge stroke upon collapsing of the tube structure in response to the action of actuating fluid in the actuating region.

Preferably, one end of the tube structure is closed and the other end is connected to a port through which pumped fluid can enter into and discharge from the pumping chamber as the pumping chamber performs intake and discharge
10 strokes.

Preferably, the tube structure is supported at the closed end thereof.

Preferably, the closed end of the tube structure is movably supported to accommodate longitudinal extension and contraction of the tube structure. The closed end of the tube structure may be movably supported in any appropriate
15 fashion such as by way of a spring mechanism.

Preferably the actuating region comprises an actuating annulus substantially surrounding the tube structure and an actuating chamber located at the closed end of the pump. Preferably the actuating annulus is in fluid communication with the actuating chamber.

20 Preferably the pump comprises means to bleed fluid, such as air, therefrom.

Preferably the pump comprises separate means to bleed air from the pumping chamber and from the actuating region, wherein the air is bled from the pumping chamber during the intake stroke and air is bled from the actuating region during the discharge stroke.

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According to a fourth aspect of the invention there is provided a pumping system comprising

at least two pumps each having a pumping chamber accommodated in an actuating region,

5 a delivery means for delivering pumped fluid to each pumping chamber in timed sequence, causing each pumping chamber to undergo an intake stroke, and

means for supplying actuating fluid to each actuating region in timed sequence to cause a respective tube structure of the pumping chamber to
10 laterally collapse whereby the pumping chamber undergoes a discharge stroke,

whereby the sequential operation of the at least two pumps expels a generally uninterrupted supply of pump fluid from the pumping system.

Preferably each pumping chamber comprises a flexible and substantially inelastic
15 tube structure.

Preferably the pumping chamber has one end closed and the other end connected to a port through which pumped fluid can enter into and discharge from the pumping chamber as the pumping chamber performs intake and discharge strokes. Preferably the closed end of the pumping chamber is elevated in relation
20 to the other end thereof.

According to a fifth aspect of the invention there is provided a method of operating a pumping system in accordance with the fourth aspect of the invention wherein the duration of the discharge stroke of one pump is longer than the duration of the intake stroke of the other pump, and vice versa, whereby, when operated
25 sequentially, the pumping system delivers a generally uninterrupted supply of fluid.

The Claims Defining the Invention are as Follows

1. A pump for conveying a pumped fluid using an actuating fluid, the pump comprising a rigid outer casing defining an interior space, a tube structure accommodated in the interior space, the tube structure being flexible and substantially inelastic, the interior of the tube structure defining a pumping chamber for receiving pumped fluid, the tube structure being movable between laterally expanded and collapsed conditions for varying the volume of the pumping chamber thereby to provide discharge and intake strokes, tube structure being maintained in a taut condition between the ends thereof, the region of the interior space surrounding the tube structure defining an actuating region for receiving and accommodating actuating fluid, the pumping chamber being adapted to receive pumped fluid to cause the tube structure to move towards the expanded condition and the pumping chamber thereby undergoing an intake stroke, the pumping chamber undergoing a discharge stroke upon collapsing of the tube structure in response to the action of actuating fluid in the actuating region.
2. A pump according to claim 1 wherein one end of the tube structure is closed and the other end is connected to a port through which pumped fluid can enter into and discharge from the pumping chamber as the pumping chamber performs intake and discharge strokes.
3. A pump according to claims 1 or 2 wherein the tube structure is supported at the closed end thereof.
4. A pump according to any one of claims 2 to 3 wherein the closed end of the tube structure is movably supported to accommodate longitudinal extension and contraction of the tube structure.
5. A pump according to any one of claims 2 to 6 wherein the closed end of the tube structure is movably supported in any appropriate fashion such as by way of a spring mechanism.

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6. A pump according to any one of claims 2 to 5 wherein the actuating region comprises a actuating annulus substantially surrounding the tube structure and a actuating chamber located at the closed end of the pump.
- 5 7. A pump according to claim 6 wherein the actuating annulus is in fluid communication with the actuating chamber.
8. A pump according to any one of the preceding claims comprising means to bled fluid, such as air, from the pump.
- 10 9. A pump according to claim 8 comprising separate means to bled air from the pumping chamber and actuating region, wherein the air is bled from the pumping chamber during the intake stroke and air is bled from the actuating region during the discharge stroke.
- 10.A pump according to any one of the preceding claims comprising a monitoring means to monitor the pump during the intake and discharge stroke.
- 15 11.A pump according to claim 10 wherein the monitoring means monitors the condition of the tube structure.
- 12.A pump according to claim 10 or 11 wherein the monitoring means monitors, directly or indirectly, the position of the closed end of the tube structure.
- 20 13.A pump according to claim 10 wherein the monitoring means monitors the pressure differential between components of the pump.
- 14.A pump according to any one of claims 10 to 13 wherein the monitoring means at least indicates when the discharge and intake strokes have been completed.
- 25 15.A pumping system comprising a pump in accordance with any one of claims 1 to 14, a delivery means for delivering pumped fluid to the pumping

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chamber in timed sequence for causing the pumping chamber to undergo an intake stroke, and means for supplying actuating fluid to the actuating region in timed sequence to cause the tube structure to laterally collapse whereby the pumping chamber undergoes a discharge stroke.

5 16.A pumping system according to claim 15 wherein the delivery means comprises a delivery pump.

17.A pumping system according to claim 15 or 16 wherein the actuating fluid is of any appropriate form, such as hydraulic oil or water.

10 18.A pumping system according to claim 17 wherein the actuating fluid is hydraulic oil.

19. A pumping system according to claim 18 wherein the supply means includes a hydraulic circuit incorporating a reservoir for hydraulic oil and a hydraulic pump.

15 20.A pumping system according to claim 19 wherein the hydraulic circuit also includes an intake and exit valve system for regulating the delivery of hydraulic oil into, and the discharge of hydraulic oil from, the actuating region in timed sequence.

21.A pumping system according to claim 17 wherein the actuating fluid is water.

20 22.A pumping system according to claim 21 wherein the supply means comprise a water reservoir at an elevated location in order to supply the water at the appropriate pressure head.

25 23.A pumping system according to any one of claims 15 to 22 wherein the delivery of the actuating fluid to the actuating region is at an opposed end to the port through which pumped fluid enters into and discharges from the pumping chamber..

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24. A pumping system according to any one of claims 15 to 23 wherein the outlet of the actuating fluid from the actuating region is also at an opposed end to the port through which pumped fluid enters into and discharges from the pumping chamber.
- 5 25. A pumping system according to any one of claims 15 to 24 comprising two pumps in accordance with claims 1 to 14 operating sequentially such that the pumping chamber of one pump performs an intake stroke while the pumping chamber of the other pump performs a discharge stroke, and vice versa.
- 10 26. A pumping system according to claim 25 wherein the sequential operation of the two pumps is such that a generally uninterrupted supply of pumped fluid is expelled from the pumping system.
27. A pumping system according to claim 25 or 26 wherein the duration of the discharge stroke is longer than the duration of the intake stroke.
- 15 28. A pumping system according to claims 25, 26 or 27 wherein one pump completes its intake stroke and commences its discharge stroke while the other pump is completing its discharge stroke.
- 20 29. A pumping system according to any one of claims 25 to 28 wherein the discharge stroke of one pump is completed by the time the discharge from the other pump is equal in flow to the desired flow of pump fluid from the pumping system.
30. A pumping system according to any one of claims 25 to 29 wherein the two pumps have a common delivery means and a common supply means, with appropriate valve systems controlling the sequence of operation.
- 25 31. A pumping system according to any one of claims 25 to 30 wherein the or each pump is oriented so that the closed end of the tube structure is elevated in relation to the other end thereof.

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32.A pumping system according to any one of claims 25 to 31 wherein the delivery and exit of the actuating fluid to the actuating region is adjacent the closed end.

5 33.A pump for conveying a pumped fluid using a actuating fluid, the pump comprising a rigid outer casing defining an interior space, a flexible tube structure accommodated in the interior space, the interior of the tube structure defining a pumping chamber for receiving pumped fluid, the tube structure being movable between laterally expanded and collapsed conditions for varying the volume of the pumping chamber thereby to
10 provide discharge and intake strokes, one end of the tube structure being closed and the other end communicating with a port through which pumped fluid can enter into and discharge from the pumping chamber as the pumping chamber performs the intake and discharge strokes, the region of the interior space surrounding the tube structure defining an actuating
15 region for receiving actuating fluid, the pumping chamber being adapted to receive pumped fluid to cause the tube structure to move towards the expanded condition and the pumping chamber thereby undergoing an intake stroke, the pumping chamber undergoing a discharge stroke upon collapsing of the tube structure in response to the action of actuating fluid
20 in the actuating region.

34.A pump according to claim 33 wherein the tube structure is substantially inelastic.

25 35.A pump according to claim 35 or 36 wherein the port through which fluid enters the pumping chamber is at an opposed end to where the actuating fluid enters the pump.

36.A pumping system comprising

at least two pumps each having a pumping chamber accommodated in an actuating region,

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a delivery means for delivering pumped fluid to each pumping chamber in timed sequence, causing each pumping chamber to undergo an intake stroke, and

5 means for supplying actuating fluid to each actuating region in timed sequence to cause a respective tube structure of the pumping chamber to laterally collapse and the pumping chamber undergoing a discharge stroke,

whereby the sequential operation of the at least two pumps expels a generally uninterrupted supply of pump fluid from the pumping system.

10 37.A pumping system according to claim 26 wherein each pumping chamber comprises a flexible and substantially inelastic tube structure.

38.A pumping system according to claims 36 or 37 wherein the pumping chamber has one end closed and the other end connected to a port through which pumped fluid can enter into and discharge from the pumping chamber as the pumping chamber performs intake and discharge strokes.
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39.A pumping system according to claim 38 wherein the closed end of the pumping chamber is elevated in relation to the other end thereof.

40.A method of operating a pumping system in accordance with any one of claims 36 to 39 wherein the duration of the discharge stroke of one pump is longer than the duration of the intake stroke of the other pump, and vice versa, whereby, when operated sequentially, the pumping system delivers a generally uninterrupted supply of fluid.
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41.A pump for conveying a pumped fluid using an actuating fluid, the pump comprising a rigid outer casing defining an interior space, a tube structure accommodated in the interior space, the tube structure having one end closed and in an elevated position in to relation to the other end, which communicates with a port through which pumped fluid can enter into and
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5 discharge from the pumping chamber, the interior of the tube structure
defining a pumping chamber for receiving pumped fluid, the tube structure
being movable between laterally expanded and collapsed conditions for
varying the volume of the pumping chamber thereby to provide discharge
and intake strokes, the region of the interior space surrounding the tube
structure defining an actuating region for receiving actuating fluid, the
pumping chamber being adapted to receive pumped fluid to cause the tube
structure to move towards the expanded condition and the pumping
chamber thereby undergoes an intake stroke, the pumping chamber
10 undergoing a discharge stroke upon collapsing of the tube structure in
response to the action of actuating fluid in the actuating region.

42.A pump according to claim 41 wherein the actuating fluid enters the
actuating region adjacent the closed end of the pumping chamber.

15 43.A pump according to claims 41 or 42 wherein the tube structure is flexible
and substantially inelastic.

44.A pump as substantially herein described with reference to the drawings.

45.A pumping system as substantially herein described with reference to the
drawings.

20 46.A method of operating a pumping system as substantially herein described
with reference to figure 18.